United States Environmental Protection Agency
Region 4
Science and Ecosystem Support Division
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Athens, Georgia 30605-2720

Proctor Creek Watershed Monitoring
Second Quarterly Sampling Event
Final Report

Fulton County, GA
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SESD Project Identification Number: 16-0141

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Title & Approval Sheet

Title: Proctor Creek Watershed Monitoring: Second Quarterly Sampling Event

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1.0 Introduction

The Proctor Creek Watershed is located in Fulton County, Georgia, in the city of Atlanta (Figure 1). Nine miles of the main channel of Proctor Creek are currently on the Georgia Environmental Protection Division (EPD) 303(d) list for impairment due to fecal coliform bacteria. The current study is part of a multi-year water quality monitoring project to assess both baseflow and stormflow conditions in the watershed (USEPA 2015a). Multiple locations in the watershed are being sampled on a quarterly basis, while stormwater will be sampled periodically at up to three gauging stations during significant rain events. This report contains results from the second quarterly monitoring event.

2.0 Methods

2.1 Study Design and Methods

This study was conducted in accordance with the methods outlined in the Proctor Creek Watershed Monitoring Quality Assurance Project Plan (USEPA 2015a). Field sampling was performed on January 12-13, 2016. Sampling locations, which included stations in the mainstem of Proctor Creek as well as seven of its tributaries, are listed in Table 1 and shown in Figure 2. Discharge was estimated at most locations using an acoustic Doppler velocimeter and standard stream gauging techniques (USEPA 2012b). Discharge data for James Jackson (PC8) was obtained via the United States Geological Survey (USGS) real-time streamflow data for Station Number 02336526: Proctor Creek at Jackson Parkway, available online at http://waterdata.usgs.gov. *In situ* water quality measurements of temperature, pH, specific conductance, dissolved oxygen and turbidity were obtained using YSI multi-parameter sondes (USEPA 2013b).

Water samples for fecal bacteria indicators, nutrients, classical parameters, and total recoverable metals were collected in accordance with the SESD standard operating procedure for surface water sampling (USEPA 2013c). All samples, except those for fecal bacteria indicators, were analyzed by the Analytical Support Branch (ASB) at SESD in accordance with the ASB Laboratory Operations and Quality Assurance Manual (USEPA 2015b). Water samples for fecal bacteria analysis were delivered to the EPA Office of Research and Development (ORD) laboratory in Athens, GA for immediate processing (within 6 hours of collection).

Water chemistry data were compared to Georgia Water Quality Standards (WQS), which include freshwater aquatic life criteria at both chronic and acute exposure levels, calculated using hardness concentrations at each station where applicable (Ga. Comp. R. & Regs. r. 391-3-6-.03). Although samples were not collected according to methods used to determine chronic exposure level violations, which require more than one sampling event, these levels were still used for comparison because they are the most protective of aquatic life. Since Proctor Creek is not used as a drinking water source, water chemistry data were not compared to state drinking water standards.

3.0 Results

3.1 *In situ* Water Quality

Dissolved oxygen (DO) was relatively low, at approximately 3 mg/L, downstream of the North Avenue CSO outfall (North CSO; PC4) where water flow was minimal. This DO level is potentially below the state water quality standard of 4.0 mg/L to support warm water species of fish, depending on stream classification and other factors. Specific conductance was approximately 350 µS/cm or less throughout most of the watershed, but slightly higher in three tributaries: North CSO (PC4; 604 µS/cm), AD Williams (PC13; 525 µS/cm) and West Highlands (PC15; 612 µS/cm). Other *in situ* parameters, temperature, pH and turbidity, were at normal levels and within acceptable limits according to Georgia water quality criteria (Ga. Comp. R. & Regs. r. 391-3-6-.03).

3.2 Precipitation and Discharge

There was no precipitation during the sampling period, but two small rain events of approximately 0.25 inches each occurred during the week prior to sampling (http://waterdata.usgs.gov). The USGS Jackson Parkway gauge recorded discharge of 7.4 cubic feet per second (cfs) at the start of sampling, which had dropped slightly to 7.2 cfs by the time of completion (Figure 3). Discharge measurements are shown in Table 2. Water level and/or velocity was too low to obtain acceptable measurements at North CSO (PC4), Lindsay Street (PC10) and Lillian Cooper (PC14). The flow transect at Northwest (PC9) included a large number of negative values due to shallow sandy regions, and was therefore estimated using proportional data from subsequent flow measurements at this location. Discharge increased from 0.35 to approximately 9 cfs from upstream to downstream in the main channel of Proctor Creek (Figure 4).

3.3 *Escherichia coli*

Data for fecal coliform counts are provided in Table 2, reported as the most probable number (MPN) of *E. coli* per 100 mL. While the Georgia state water quality standard is written in terms of fecal coliform, not specifically *E. coli*, the *E. coli* data provide a conservative estimate of fecal coliform since they are a subset of this group. Therefore, exceedance of the standard by *E. coli* indicates a likely exceedance by fecal coliform bacteria as a whole. The applicable standard for this sampling period (between November and April) for fishing and/or recreational waters is a geometric mean of 1,000 per 100 mL, calculated using at least four samples during a 30-day period, not to exceed a maximum of 4,000 per 100 mL in any individual sample (Ga. Comp. R. & Regs. r. 391-3-6-.03(6).

Only one sample was collected at each station during this sampling event, which precludes the calculation of a geometric mean. However, eight samples contained concentrations of *E. coli* higher than that standard and two samples exceeded the maximum allowable concentration of 4,000 MPN/100 mL (Table 2). Counts were extremely high in Proctor Creek at North Avenue (PC3), at over 26,000 MPN per 100 mL, which is well above the water quality criterion. Levels were also relatively high in Proctor Creek at the next station upstream, Burbank (PC1), and elevated at several stations downstream of North Avenue.

3.4 Surface Water Chemistry

Inorganic chemistry data for surface water samples are shown in Tables 3-4. Total nitrogen (TN) was highest at Lindsay Street (PC10; Figure 5), where nitrate-nitrite accounted for more than 95% of the total, whereas ammonia was highest at AD Williams (PC13) and West Highlands (PC15). Total phosphorus (TP) peaked at Greensferry (0.32 mg/L) and was still elevated downstream of that station in Proctor Creek (PC3). Dissolved phosphorus accounted for >90% TP at those locations. TP was lower at all other stations (Figure 6), with the dissolved fraction ranging from 0-58%. Total organic carbon (TOC) was below detection throughout most of the main channel of Proctor Creek, but ranged from approximately 8-10 mg/L in three tributaries: North CSO (PC4), AD Williams (PC13) and West Highlands (PC15).

Classical parameters and metals were somewhat uniform throughout the watershed, with a few exceptions. Where TOC was elevated (North CSO, AD Williams and West Highlands), total alkalinity, chloride, sulfate, calcium, magnesium, potassium, sodium and strontium were also generally higher. This was reflected in the specific conductance measurements at these three stations, as higher concentrations of ions increase water conductivity. A few metals (antimony, lead and zinc) were elevated only at North CSO (PC4), Hortense (PC6), or Lindsay Street (PC10). However, there was just one sample with a concentration above any applicable water quality criteria, with lead at Hortense Avenue above the chronic freshwater aquatic life criterion. Analytes not detected in any water chemistry samples are listed in Table 5.

3.5 Quality Control

Quality control activities associated with field operations included a filter blank for dissolved phosphorus, temperature blanks for sample coolers and multi-meter instrument calibrations. Dissolved phosphorus in the filter blank sample was below detection. Temperature blank results indicate that water samples were below 4°C when received by the SESD Analytical Support Branch (ASB). All samples arrived at ASB in good condition and with a complete chain of custody. All YSI water quality instruments used during this study were maintained and calibrated according to requirements of the SESD Operating Procedure for Equipment Inventory and Management (USEPA 2013a). YSI instruments were operated within the ranges established by the manufacturer and therefore were within acceptable field measurement uncertainty guidelines (Table 6; USEPA 2012a). At the end of each sampling day, instruments were end-checked using the appropriate standard for each parameter measured. End check results indicate all instrument measurements were within acceptable limits.

4.0 Discussion

Results from this sampling event were generally consistent with data from the initial sampling event in September 2015 (USEPA 2016). Concentrations of nutrients and fecal bacteria were highest in the upper end of the watershed, where the western Atlanta urban area drains into the headwaters of Proctor Creek. In contrast, metals were primarily elevated in three of the tributaries, yet relatively uniform throughout the main channel of Proctor Creek. However, there were some differences between the September and January sampling dates that may be attributed to season as well as precipitation.

The highest concentrations of nutrients occurred in the downtown area. This included the tributaries downstream of the North Avenue (PC4) and the decommissioned Greensferry (PC2) CSO facilities, an upstream tributary at Lindsay Street (PC10), and the mainstem Proctor Creek station at North Avenue (PC3). Total phosphorus was highest at the Greensferry tributary (PC2) and just below its confluence in Proctor Creek at North Avenue (PC3), where dissolved fractions were high, but relatively low or below detection at all other stations. Total nitrogen was also elevated at Greensferry, as well as Lindsay Street, where nitrate-nitrite was a large percentage of the total. Compared to September, TP and TN concentrations were very similar overall, but TP was slightly lower in the upper watershed and TN was slightly higher in the lower watershed during the January event.

Total organic carbon was again higher in the tributaries, at concentrations 2X or more greater than in September at a few stations: North Avenue CSO (PC4), West Highlands (PC15) and AD Williams (PC13). Those stations also had elevated conductivity, including the individual ions calcium, potassium, magnesium and sodium, as well as total alkalinity, chloride and sulfate. This suggests that various sources upstream of each station may be influencing water chemistry via runoff. The North Avenue CSO tributary drains a portion of downtown Atlanta, thereby receiving urban runoff from this region. The tributary at West Highlands is downstream of a large railroad transfer station, and the tributary at AD Williams is downstream of two landfills as well as some industrial facilities.

E. coli levels followed a different pattern during this event than in September, in that the highest concentrations were found in the main channel of Proctor Creek rather than the tributary at Greensferry. Levels were relatively high (9,762 MPN/100 mL) at the uppermost station, Burbank Drive (PC1), then peaked at over 26,000 MPN downstream of the Greensferry confluence at North Avenue (PC3). Additionally, concentrations in mainstem Proctor Creek remained relatively high compared to the tributaries throughout the channel. At the station furthest downstream at Northwest Drive (PC9), *E. coli* levels were still above the water quality standard of 1,000 per 100 mL.

Seasonal patterns in nutrient concentrations help to explain the differences in nitrogen, phosphorus and carbon between the September and January sampling events. Nitrogen may have been somewhat higher due to lower stream temperatures, which can lead to decreased uptake and denitrification rates (*e.g.*, Lee et al. 2012). Increased precipitation rates due to an El Niño year also likely affected instream nutrients as well as biota. Total precipitation in December 2015 was approximately 9.5 inches at Proctor Creek at James Jackson Parkway (www.nwis.waterdata.usgs.gov), compared to the 30-year average of 3.9 inches for Atlanta, GA (www.usclimatedata.com). High flows resulting from the above-average rainfall may have flushed contaminants, including fecal bacteria, through tributaries into the main channel of Proctor Creek. Furthermore, changes in the proportion of groundwater to surfacewater runoff can also affect nutrient concentrations, and cause fluctuations throughout the year (*e.g.*, Mulholland and Hill 1997, Lee et al. 2012).

5.0 Conclusions

This was the second quarterly sampling event in a long-term monitoring study. Results of all sampling events will be compiled at the end of the study to provide a comprehensive summary. Two or more years of quarterly data will establish a baseline against which progress may be measured, as various improvement projects move forward in the Proctor Creek watershed.

6.0 References

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USEPA. 2013b. Operating Procedure for *In Situ* Water Quality Monitoring, SESDPROC-111-R3, Region 4, SESD, Athens, GA.

USEPA. 2013c. Operating Procedure for Surface Water Sampling, SESDPROC-201-R3, Region 4, SESD, Athens, GA.

USEPA. 2013d. Standard Operating Procedure (SOP) for the Determination of Total Hardness by Calculation. SOP SM 2340 B, Revision 2.0.

USEPA. 2015a. Proctor Creek Watershed Monitoring, Quality Assurance Project Plan. SESD Project ID #15-0425. Region 4, SESD, Athens, GA.

USEPA. 2015b. SESD Analytical Services Branch Laboratory Operations and Quality Assurance Manual (ASB LOQAM). United States Environmental Protection Agency. Region 4, SESD, Athens, GA.

USEPA. 2016. Proctor Creek Watershed Monitoring: First Quarterly Sampling Report. United States Environmental Protection Agency. Region 4, SESD, Athens, GA.

Table 1: Sampling locations in the mainstem (MAIN) and tributaries (TRIB) of Proctor Creek.

Station ID	Station Name	Location Type	Location Description	Location (Decimal Degrees)	
				Latitude	Longitude
PC1	Burbank	MAIN	Proctor Creek at Burbank Drive	33.75710	-84.42892
PC2	Greensferry	TRIB	Tributary downstream of decommissioned Greensferry CSO	33.76075	-84.42691
PC3	North Avenue	MAIN	Proctor Creek at North Avenue	33.76800	-84.42769
PC4	North CSO	TRIB	Tributary downstream of North Avenue CSO outfall	33.76863	-84.42689
PC5	Hollowell	MAIN	Proctor Creek at Hollowell Parkway	33.77199	-84.42990
PC6	Hortense	MAIN	Proctor Creek at Hortense Place	33.77562	-84.44072
PC7	Kerry Circle	MAIN	Proctor Creek at Kerry Circle	33.79214	-84.45208
PC8	James Jackson	MAIN	Proctor Creek at James Jackson Parkway	33.79461	-84.47417
PC9	Northwest	MAIN	Proctor Creek at Northwest Drive	33.79931	-84.48682
PC10	Lindsay Street	TRIB	Tributary at Lindsay Street Park	33.76941	-84.41611
PC11	Grove Park	TRIB	Tributary at Grove Park	33.77406	-84.44029
PC12	Spring Street	TRIB	Tributary at Spring Street	33.78849	-84.46597
PC13	AD Williams	TRIB	Tributary at Northwest Drive	33.79633	-84.48602
PC14	Lillian Cooper	TRIB	Tributary at Lillian Cooper Shepherd Park	33.79799	-84.47842
PC15	West Highlands	TRIB	Tributary at Hollingsworth Boulevard	33.79076	-84.44724

Table 2: Data from *in situ* water quality measurements, discharge calculations, and fecal bacteria analyses.

Station ID	Station Name	Date	Time	Temp. (°C)	Sp. Cond. (µS/cm)	pH (S.U.)	Turbidity (NTU)	D.O. (mg/L)	Discharge (cfs)	*E. coli* (MPN/100mL)
PC1	Burbank	1/13/16	13:08	8.36	190	6.98	1.4	11.61	0.346	9,762
PC2	Greensferry	1/13/16	12:28	15.67	356	7.09	2.0	8.54	0.950	2,889
PC3	North Avenue	1/13/16	11:36	11.28	277	7.22	1.4	10.96	1.668	26,879
PC4	North CSO	1/13/16	11:02	7.72	604	6.42	2.5	3.20	NA	68
PC5	Hollowell	1/12/16	14:11	10.13	298	7.29	1.4	11.05	2.164	2,270
PC6	Hortense	1/12/16	13:07	6.98	259	7.62	3.6	11.85	3.825	3,015
PC7	Kerry Circle	1/12/16	11:29	5.02	277	7.36	4.5	11.76	4.417	1,411
PC8	James Jackson	1/12/16	12:30	4.54	258	7.53	2.9	12.87	7.4*	880
PC9	Northwest	1/12/16	10:10	3.77	279	6.95	3.4	12.05	9.2*	3,746
PC10	Lindsay Street	1/13/16	13:51	14.01	351	6.67	1.0	9.04	NA	795
PC11	Grove Park	1/12/16	14:25	7.61	206	7.66	3.5	11.70	1.126	175
PC12	Spring Street	1/12/16	10:37	4.64	185	7.41	8.2	12.28	1.604	2,589
PC13	AD Williams	1/12/16	11:07	5.36	525	7.41	4.0	11.68	0.404	67
PC14	Lillian Cooper	1/12/16	11:56	7.58	140	7.39	5.7	10.21	NA	145
PC15	West Highlands	1/12/16	12:25	9.5	612	7.33	9.0	10.08	0.286	86

*Discharge at PC8 was obtained from USGS gauge data available online at http://waterdata.usgs.gov/ga/nwis for station number 02336526, Proctor Creek at Jackson Parkway. Discharge at PC9 was estimated using proportional data from subsequent measurements at this station compared to station PC8.

Table 3: Surface water data for nutrient and classical analyses.

SURFACE WATER NUTRIENTS/CLASSICALS															
	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8	PC9	PC10	PC11	PC12	PC13	PC14	PC15
Analyte (mg/L)	Burbank	Greens-ferry	North Avenue	North CSO	Hollowell	Hortense	Kerry Circle	James Jackson	Northwest	Lindsay Street	Grove Park	Spring Street	AD Williams	Lillian Cooper	West Highlands
Total Organic Carbon	1.0 U, J,QM-2	2.6	1.0 U	10	1.2	1.5	1.0 U	1.9	2.3	2.0	1.2	2.2	7.9	1.8	9.1
Total Phosphorus	0.020	0.32	0.23	0.032	0.10	0.045	0.030	0.018	0.031	0.063	0.012	0.024	0.012	0.015	0.010 U
Total Dissolved Phosphorus	0.010 U	0.31	0.21	0.018	0.058	0.013	0.010 U	0.010 U	0.018	0.048	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U
Total Nitrogen	2.10	3.20	2.67	2.04	2.31	2.06	1.79	1.54	1.60	4.38	1.13	1.23	2.7	0.38	1.88
Total Kjeldahl Nitrogen	0.20	1.1	0.67 J,QM-2	0.24	0.31	0.36	0.29	0.24	0.40	0.18	0.13	0.34	1.1	0.11	0.78
Ammonia as N	0.050 U	0.35	0.31	0.063	0.13	0.12	0.092	0.11	0.22	0.050 U	0.050 U	0.20	0.74	0.085	0.57
Nitrate/Nitrite as N	1.9	2.1	2.0	1.8	2.0	1.7	1.5	1.3	1.2	4.2	1.0	0.89	1.6	0.27	1.1
Alkalinity, Total (as $CaCO_3$)	49	79	75	270	76	67	73	70	75	71	48	49	160	38	230
Bromide	0.10 U, J,QM-1	0.10 U	0.10 U	0.10 U	0.10 U, J,QM-1	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.88	0.10 U	0.10 U
Chloride	12	23	14	50	19	13	13	14	15	16	12	11	49	9.9	21
Fluoride	0.073	0.22	0.17	0.20	0.15	0.13	0.13	0.14	0.14	0.26	0.093	0.14	0.15	0.090	0.22
Sulfate as SO_4	19	40	34	58	35	34	38	34	32	62	29	19	24	12	71

U = The analyte was not detected at or above the reporting limit.
J = The identification of the analyte is acceptable; the reported value is an estimate.
QM-1 = Matrix Spike Recovery less than method control limits.
QM-2 = Matrix Spike Recovery greater than method control limits.

Table 4: Surface water data for metals analyses. Detections are highlighted in grey for clarity. Acute and chronic exposure levels for aquatic life, calculated using hardness values for each station according to GABNR (2012), are provided for comparison. One sample (PC6) contained lead above the chronic exposure level, highlighted in orange.

SURFACE WATER METALS															
	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8	PC9	PC10	PC11	PC12	PC13	PC14	PC15
Analyte (µg/L)	Burbank	Greens-ferry	North Avenue	North CSO	Hollowell	Hortense	Kerry Circle	James Jackson	Northwest	Lindsay Street	Grove Park	Spring Street	AD Williams	Lillian Cooper	West Highlands
Aluminum	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	130	100 U	100 U	100 U
Antimony	1.0 U	1.0 U	1.0 U	12	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.4	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Arsenic	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0	1.0 U	1.0 U
Barium	72	66	69	100	68	58	61	56	56	76	42	48	78	55	130
Calcium	20000	30000	28000	130000	30000	27000	29000	27000	27000	39000	21000	18000	42000	12000	80000
Iron	160	270	370	700	330	330	340	320	380	120	250	470	390	1300	890
Lead	1.0 U	1.0 U	1.0 U	4.4	1.0 U	9.1	1.0 U	1.0 U	1.0 U	2.1	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Magnesium	3900	6000	5300	7700	5800	5500	5800	5400	5400	5800	4000	3100	11000	2300	13000
Manganese	47	140	130	950	140	130	130	140	140	21	86	130	440	180	810
Potassium	2700	5100	4400	7300	4600	4200	4500	4100	4200	5400	2500	2700	6400	2200	6600
Sodium	9700	23000	16000	39000	18000	14000	15000	17000	17000	19000	11000	12000	47000	9700	33000
Strontium	99	120	120	490	130	120	130	130	130	210	92	93	210	87	360
Zinc	20	10 U	11	66	15	18	23	21	18	69	13	16	17	12	36
Hardness* (mg/L)	66.0	99.6	91.7	356.3	98.8	90.1	96.3	89.7	89.7	121.3	68.9	57.7	150.2	39.4	253.3
Freshwater Aquatic Life: Acute Criteria															
Lead	40.97	64.31	58.79	249.34	63.73	57.62	61.98	57.33	57.33	79.62	42.96	35.33	100.25	23.14	174.73
Zinc	82.41	116.80	108.93	343.90	115.98	107.24	113.49	106.83	106.83	137.98	85.47	73.55	165.38	53.27	257.54
Freshwater Aquatic Life: Chronic Criteria															
Lead	1.60	2.51	2.29	9.72	2.48	2.25	2.42	2.23	2.23	3.10	1.67	1.38	3.91	0.90	6.81
Zinc	83.08	117.76	109.82	346.71	116.93	108.12	114.42	107.70	107.70	139.11	86.17	74.15	166.73	53.70	259.65

U = The analyte was not detected at or above the reporting limit.

Calculated using the formula: Hardness (as mg/L CaCO3) = (2.497(Ca, mg/L)) + (4.118*(Mg, mg/L)). (USEPA 2013d)

Table 5: Total recoverable metals not found in surface water samples at the minimum reporting limit (MRL) indicated. U = The analyte was not detected at or above the reporting limit.

Analyte	MRL (µg/L)
Beryllium	3.0 U
Cadmium	0.50 U
Chromium	5.0 U
Cobalt	5.0 U
Copper	10 U
Molybdenum	10 U
Nickel	10 U
Selenium	2.0 U
Silver	5.0 U
Thallium	1.0 U
Tin	15 U
Titanium	5.0 U
Vanadium	5.0 U
Yttrium	3.0 U

Table 6: Field measurement uncertainty ranges for YSI 6920 data sondes used to collect *in situ* water chemistry data.

Parameter	Units	Measurement Technology	Sensitivity of Primary Equipment
Dissolved Oxygen	mg/L	Luminescent dissolved oxygen probe	± 0.1 mg/L or ± 1% of reading
Temperature	°C	Thermistor	± 0.3 °C
pH	SU	Glass electrode	± 0.2 SU
Specific Conductivity	µS/cm	Nickel electrode cell	± 0.5% of reading
Turbidity	NTU	Optical probe	Greater of: ± 10% or 2 NTU

Figure 1: Study site location in Fulton County, GA. The Proctor Creek watershed drains to the Chattahoochee River, which flows across the Florida panhandle to the Gulf of Mexico.

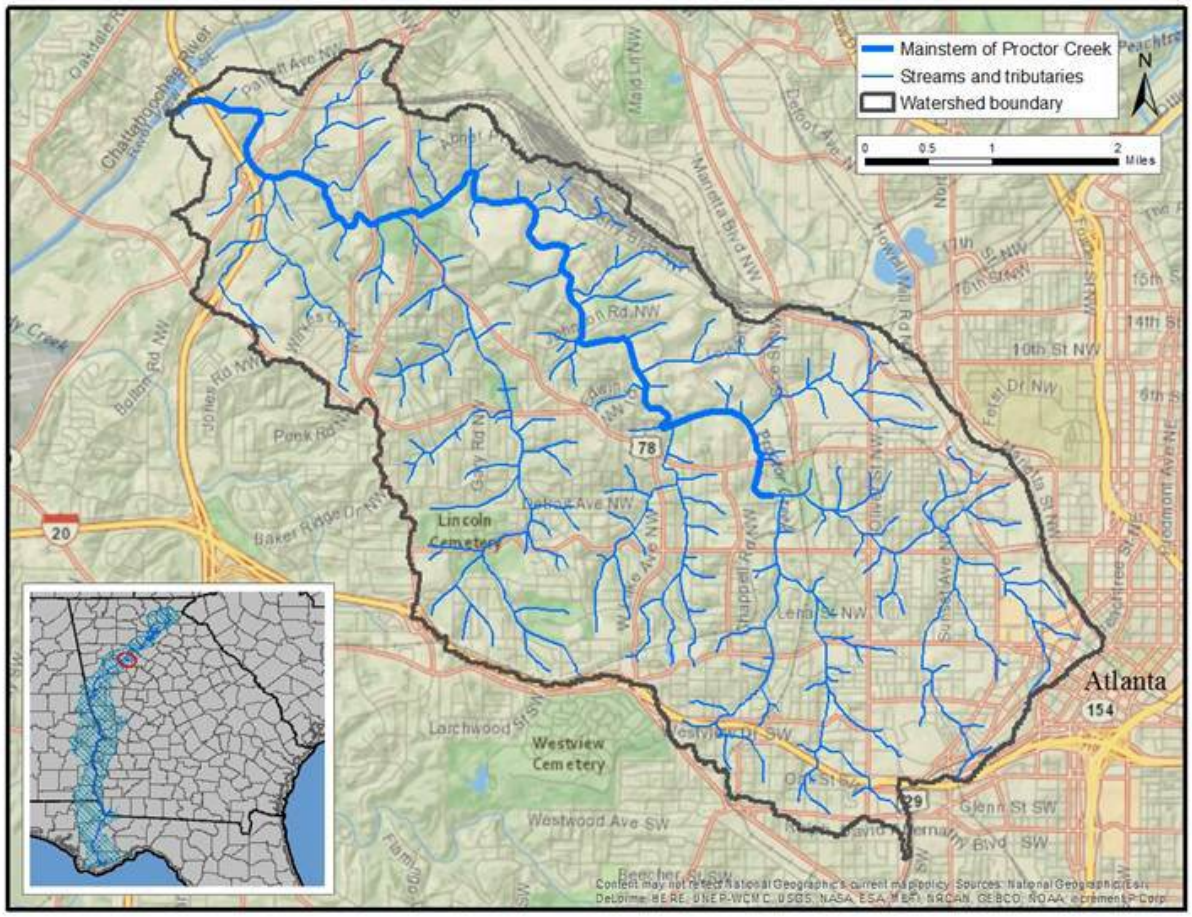


Figure 2: Map of sampling locations in the Proctor Creek watershed. The darker blue line indicates the mainstem of Proctor Creek, with tributaries shown in lighter blue. See Table 1 for station descriptions.

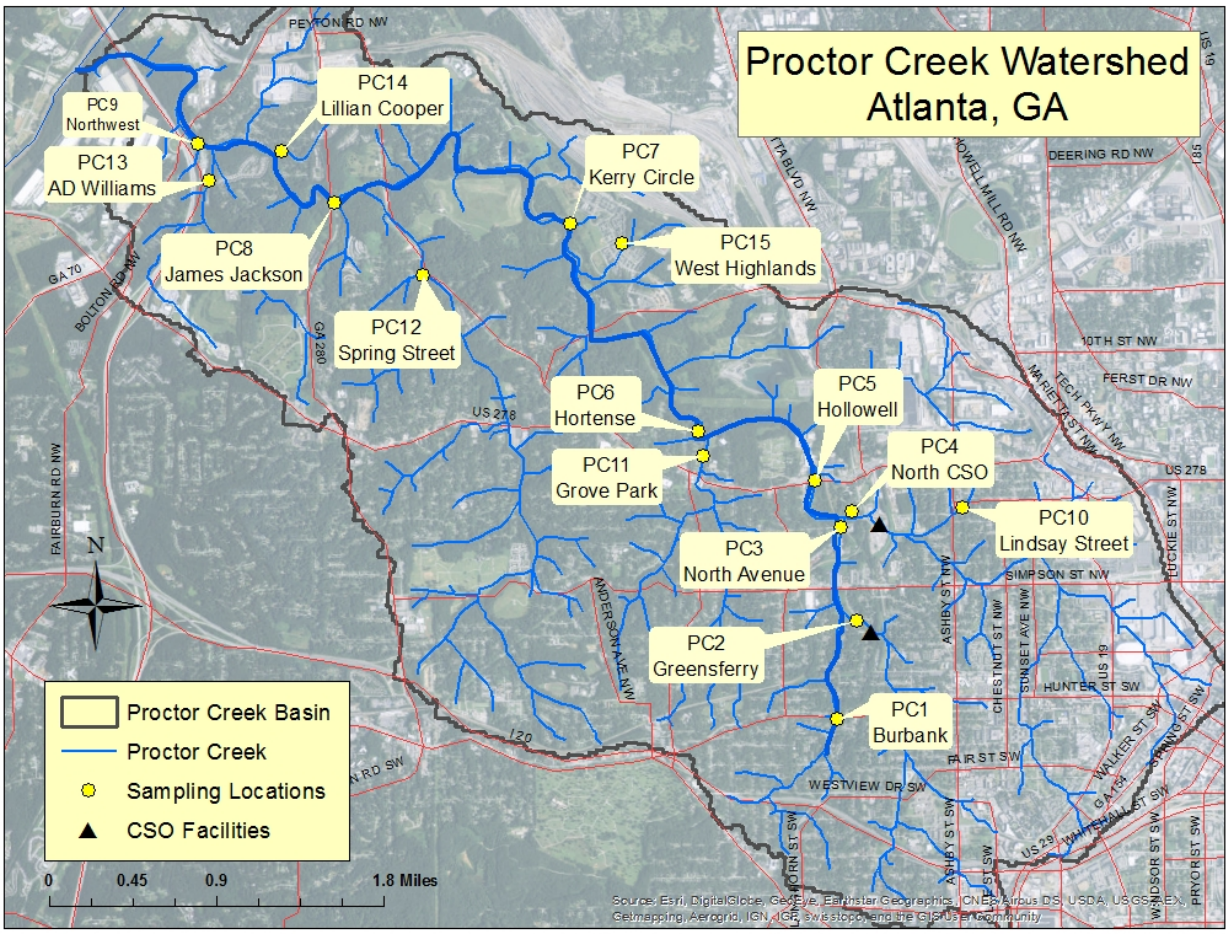


Figure 3: Discharge data from the USGS gauge #02336526, Proctor Creek at Jackson Parkway, for the week prior to and during the sampling dates of January 12-13 (http://waterdata.usgs.gov).

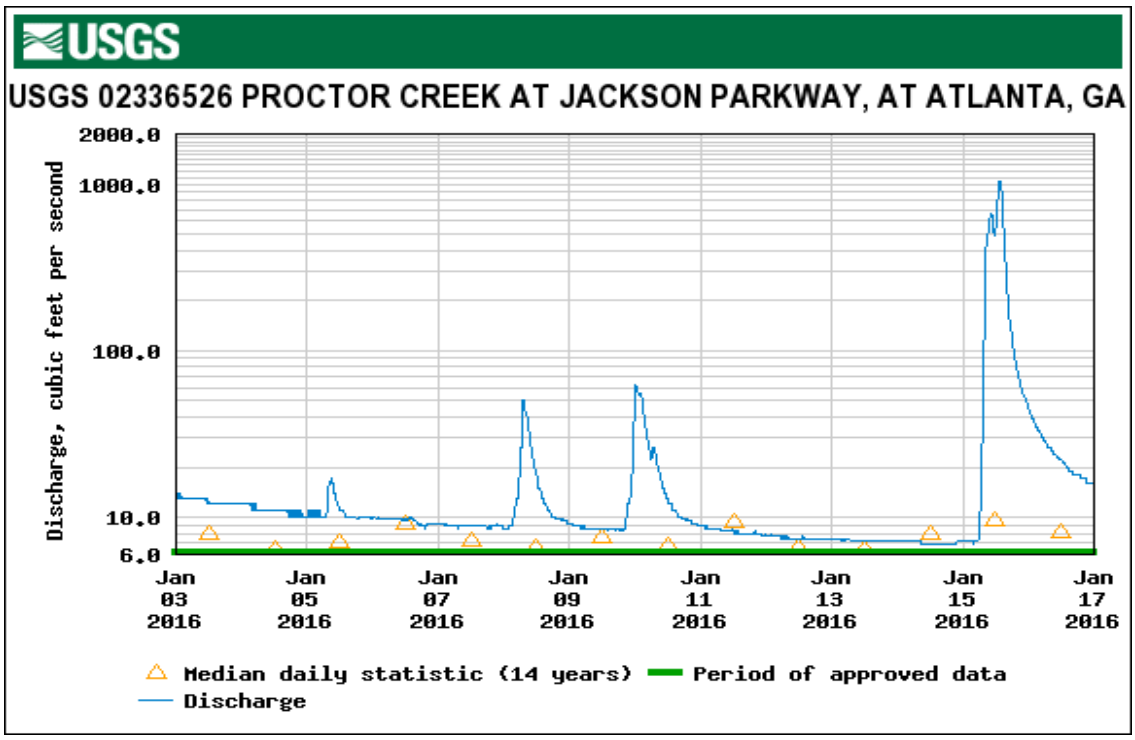


Figure 4: Discharge measured throughout Proctor Creek during the sampling event. Locations are shown from upstream to downstream, in order from left to right.

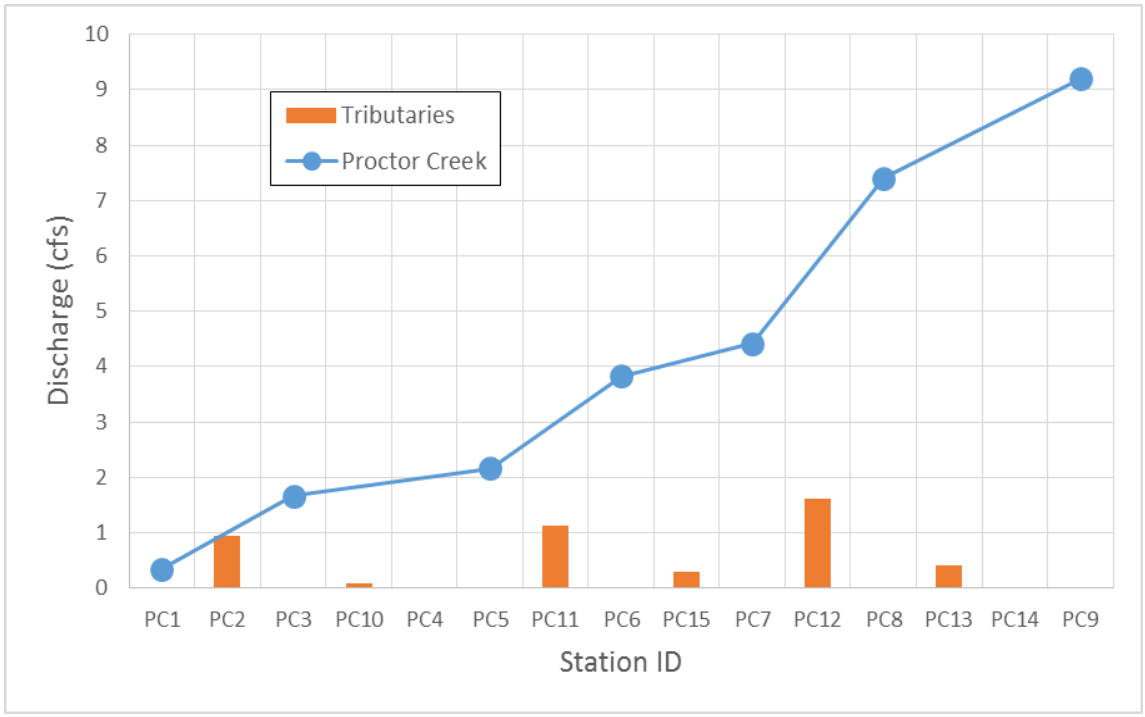


Figure 5: Total nitrogen (mg/L) in Proctor Creek and its tributaries. Locations are shown from upstream to downstream, in order from left to right.

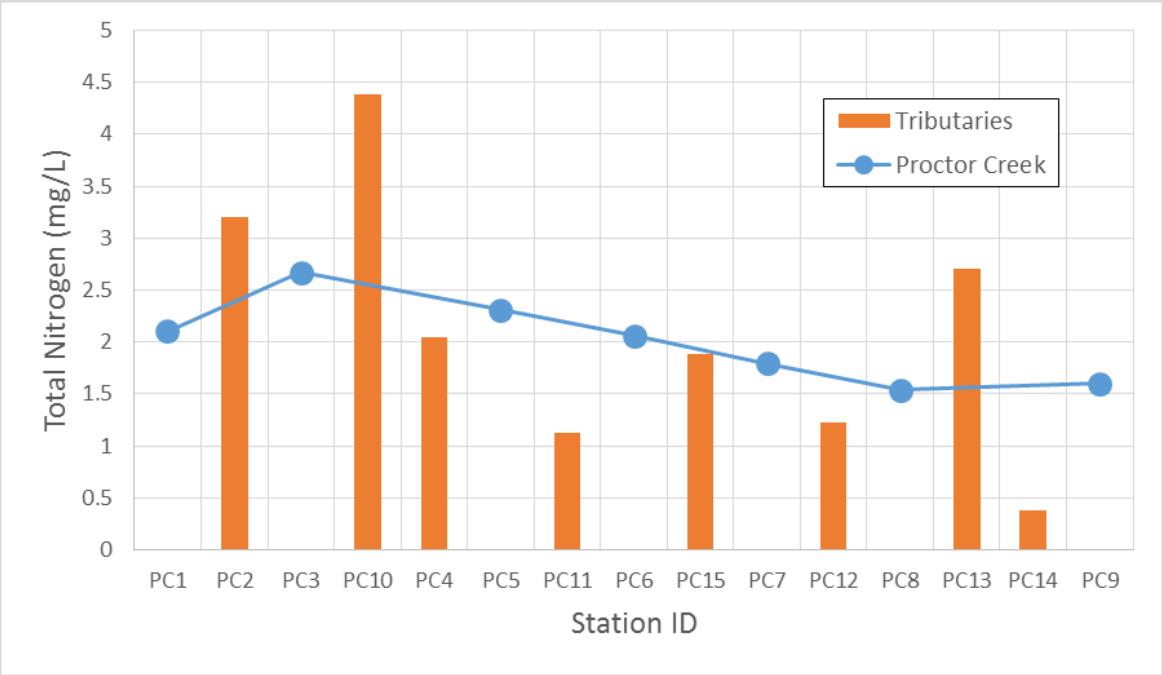
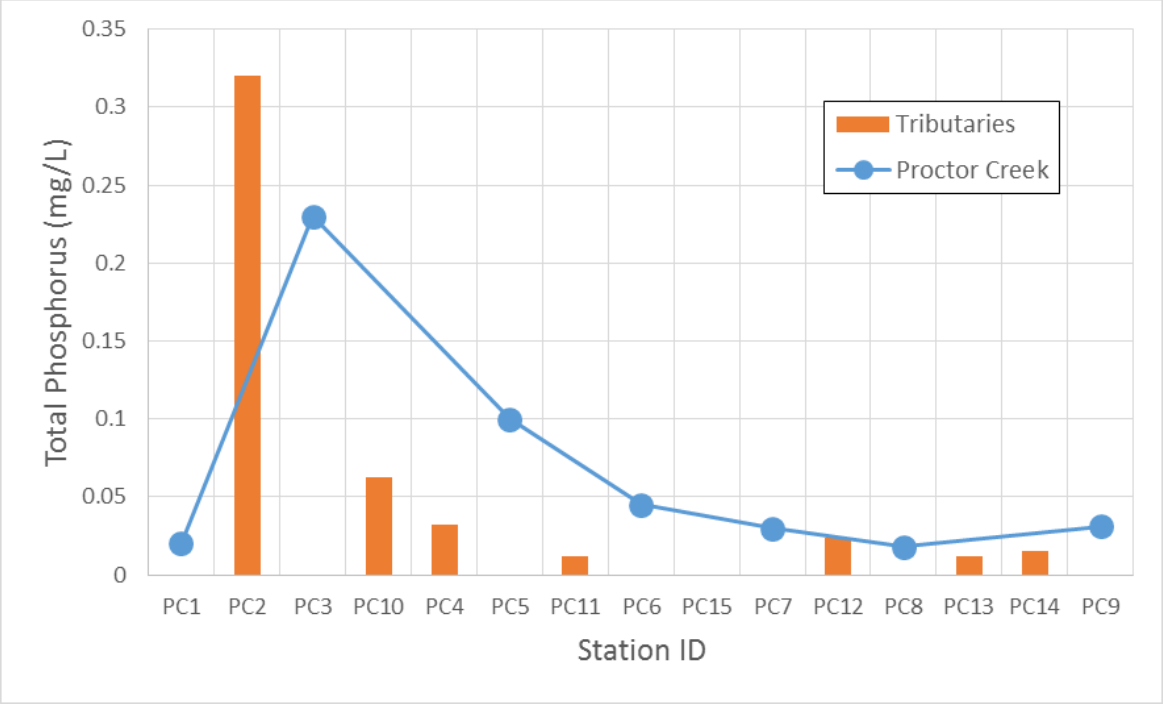


Figure 6: Total phosphorus (mg/L) in Proctor Creek and its tributaries. Locations are shown from upstream to downstream, in order from left to right.



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